# One Solution to Capturing the Benefits of Early Replacement: When Approximately Correct Is Good Enough

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## ABSTRACT

The basic early replacement situation involves a customer who installs a program-qualifying measure before the end of the effective useful life (EUL) of the customer's existing measure. However, identifying the incremental cost and savings at the end of the remaining useful life (RUL) has always been expensive and challenging. The expense and challenge of early replacement has been addressed by the New York State Department of Public Service using two approaches. One approach adjusts the lifecycle benefits calculated as the net present value of the full savings (energy use of the old equipment minus the energy use of the new efficient equipment) over the EUL. The other adjusts the EUL over which the full savings can be claimed. Since the full savings are adjusted, the full costs must also be adjusted. The adjusted results approximate the dual baseline results if one were able to obtain the incremental costs and savings. Such an approach relies on data in the Database for Energy Efficient Resources (DEER) to calculate ratios of incremental savings to full savings and incremental costs to full costs. These ratios are used to adjust the lifecycle benefits, the EUL, and the full costs. This approach has the added advantage of requiring no changes in the standard benefit cost models.

### Introduction

In the EEPS [Energy Efficiency Portfolio Standard] Order of October 18, 2010 (p.9), the New York State Public Service Commission (NYPSC) stated, regarding total resource cost (TRC) analysis of early replacements in individual projects, that it was ". . . directing Staff to develop a new approach, based on the dual baseline approach, which provides consistency between the treatment of savings and costs. The Director of the Office of Energy Efficiency and Environment is directed to compile and provide simplifying lookup tables, which provide early replacement method energy savings consistent with the dual baseline concept as an attachment to the consolidated Technical Manual (TM)." Staff was also directed "to develop a consistent cost estimation approach which reflects the concept that the costs of making a high efficiency early replacement will avoid an end-of useful-life replacement with minimally code compliant equipment."

Early replacement is defined in the Order as the replacement of equipment before it reaches its Effective Useful Life (EUL), whereas normal (end-of-life) replacement refers to the replacement of equipment which has reached or passed the end of its measure-prescribed EUL. Early replacement not only accelerates savings to the grid but also allows Program Administrators (PAs) to claim greater first-year annual savings toward their annual energy goals because first-year savings are measured against the equipment in place rather than against the

currently available minimally code or efficiency standard equipment. If a PA is uncertain whether the equipment in place has reached the end of its EUL, the replacement must be treated as normal (end-of-life) replacement, with the incremental savings (annual energy use of the standard/code compliant equipment minus the annual energy use of the new efficient equipment) reported as the first-year savings toward approved program goals.

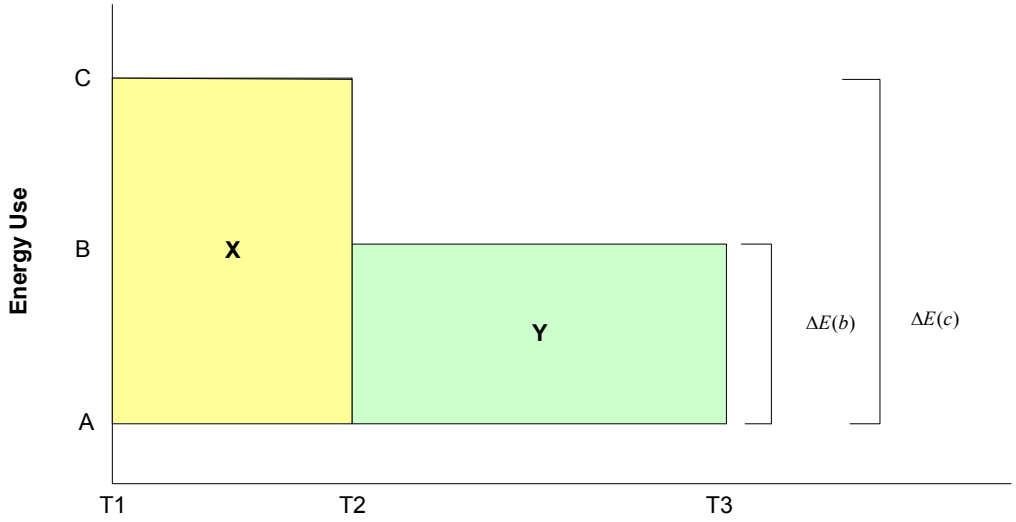
In New York, PAs can claim early replacement for custom measures and other standard measures not currently in the *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Measures* (Technical Manual) (Jacobs et al. 2010). These measures must be screened prior to approval to make sure that they pass the TRC. PAs can also claim early replacement for pre-qualified measures, which have been reviewed for cost-effectiveness by the New York State Department of Public Service (DPS) and approved for offering within a program and are addressed in the Technical Manual. For all cases of early replacement, gross savings, costs and EULs must also be entered in program-tracking databases, so that program-level TRCs can eventually be calculated.

**The Early Replacement Condition**

The basic early replacement condition, illustrated in Figure 1, involves a customer who replaces equipment before it reaches the end of its EUL. That is, the equipment is fully functioning and would continue to function for some period of time, referred to as the remaining useful life (RUL). However, the customer is induced by the program to replace this existing equipment with more efficient equipment. It is also assumed that at the end of the RUL, absent the program, the customer would have installed equipment that would meet the existing efficiency code or appliance standard (i.e., equipment that represents the market average efficiency or the efficiency that had become the industry standard (referred to as the *code/standard equipment*)).

Gross energy savings in this example would consist of two portions. The customer would have experienced the full savings defined by Area **X** (energy use C-A for the RUL period T2-T1). At the end of the RUL, the savings for the period T3-T2 would be reduced to incremental savings defined by area **Y**. To carry out these calculations, information on *two (dual) baselines* is required, the energy use of the pre-existing equipment and the energy use of code/standard equipment.

The cost would also have to be calculated in a manner that is consistent with early replacement. In normal replacement situations, one would use the incremental cost that is defined as the cost of the new efficient equipment minus the cost of the code/standard equipment. In the early replacement case, the incremental cost is calculated in a slightly different manner. This calculation recognizes that, while the customer purchased efficient equipment with the assistance of the program, it would have purchased code/standard equipment at some time in the future, i.e., at the end of the RUL, had the program not existed.




$\Delta E(c)$ = C - A

$\Delta E(b)$ = B - A

C = Energy use of existing equipment
B = Energy use of equipment that meets code
A = Energy use of the efficient equipment rebated through program
T1 = Date on which new efficient equipment is installed
T2 = Date on which existing equipment was expected to have failed
T3= Date on which the new efficient equipment is expected to fail
T3 – T1 = Expected effective useful life (EUL) of the new efficient equipment
T2 – T1 = Expected remaining useful life (RUL) of the existing equipment
T3 – T2 = Expected remaining EUL of the new efficient equipment

**Figure 1.** The Early Replacement Condition

Thus, one would first have to determine the full cost of the new efficient equipment (including the installation labor) at T1 *and* the full cost of the code/standard equipment (including the installation labor) at T2. The incremental cost would then be calculated as the present value (PV) of the cost of the new efficient equipment minus the PV of the cost of the code/standard equipment. This differs from the normal/end of life replacement incremental cost in adding a time value of money penalty for the earlier spending.

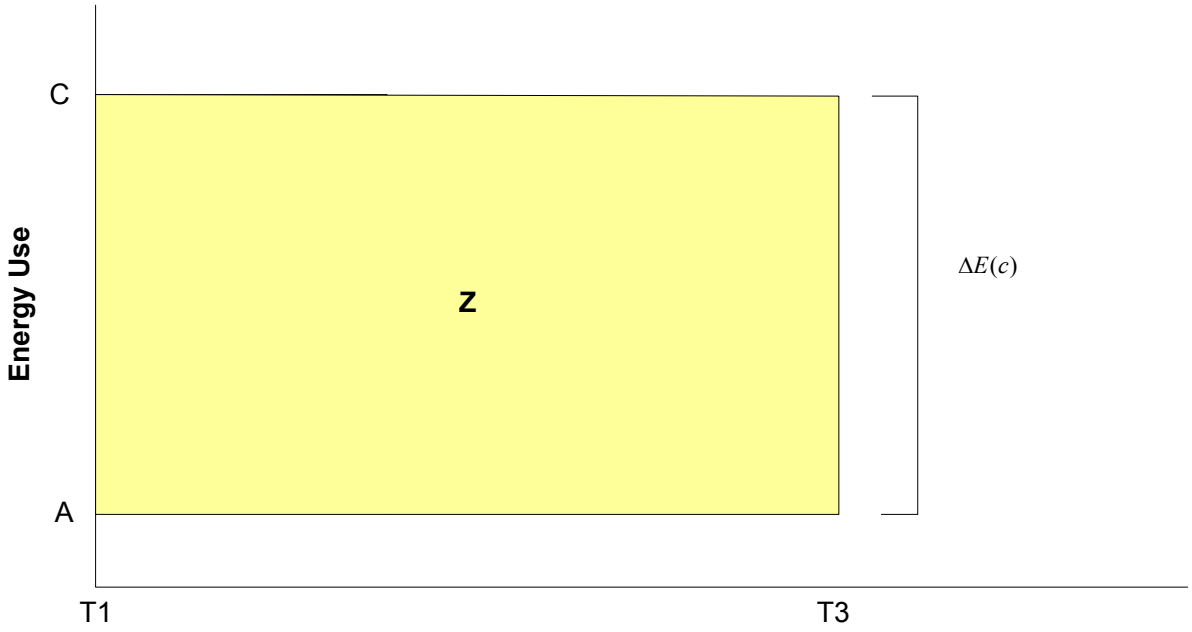
However, a PA might not be able to obtain two key inputs necessary for these calculations, the energy use and/or the cost of the code/standard equipment. Regardless, the PAs will still need to perform a dual baseline analysis as required under the Order and can apply what is called the "ratio approach."

## The Ratio Approach to the Dual Baseline with the Lookup Tables

This approach focuses on the ratio of incremental savings to full savings and the ratio of incremental costs to full costs. These ratios drive the factors that PAs can use to adjust the savings and cost data that are available. Tables were developed that only require the program administrator to have the RUL of the existing equipment and the full savings and costs of the new equipment or project.

The source of these ratios is the Database for Energy Efficient Resources (DEER), most recently updated for the California Public Utility Commission in 2009.[1] Among other items, DEER contains energy use and costs for selected energy-efficient technologies and equipment in the residential and nonresidential sectors. The database also contains the same information for typical equipment, those commonly installed in the marketplace.

To apply the ratio approach, PAs must calculate the first-year annual gross savings as the annual energy use of the old equipment in place minus the annual energy use of the high efficiency equipment (the full savings). The full savings are counted for each year of the EUL represented as Area ***Z*** in Figure 3. For each year of the EUL (**T3 – T1**) of the new equipment, the full kWh or therm savings are converted to dollar benefits by multiplying them by the NYPSC's avoided costs estimates for that year. As a preliminary step in using the tables, the PAs will calculate "inflated lifecycle benefits" as the present value of the stream of full savings benefits for the EUL of the new equipment.[2]




$\Delta E(c)$ = C - A

C = Energy use of existing equipment

A = Energy use of the efficient equipment rebated through program

T1 = Date on which new efficient equipment is installed

T3 = Date on which the new efficient equipment is expected to fail

T3 – T1 = EUL of new efficient equipment

C = Energy use of existing equipment

A = Energy use of the efficient equipment rebated through program

**Figure 2**. Inflated Lifecycle Benefits

[1] See http://www.energy.ca.gov/deer/index.html

[2] The term "inflated" refers to the fact that the calculation of the "inflated lifecycle benefits" is solely a convenient step in the use of the tables and has no other significance under the application of the ratio approach. However, it is important to note that nationally, a number of utilities have claimed the inflated lifecycle benefits for some measures. The TRC for any utility program that has relied heavily on such inflated lifecycle benefits could be significantly reduced.

In cases of early replacement under the ratio approach, it is these inflated lifecycle benefits that must be adjusted using the appropriate *inflated lifecycle benefits adjustment factor.* For a given measure with a given EUL, RUL and ratio of incremental savings to full savings, the inflated lifecycle benefits adjustment factor is the ratio of the present value of the lifecycle benefits of the dual baseline illustrated in Figure 1 to the present value of the inflated lifecycle benefits illustrated in Figure 2. PAs can obtain these factors from the set of DEER-based tables.

Under the Commission requirement of consistent treatment of savings and costs, the full costs[3] must also be adjusted downward. PAs can obtain the *full cost adjustment factors* from the DEER-based tables based on typical ratios of incremental cost to full cost.[4]

## DEER-Based Look-Up Tables

The *Inflated Lifecycle Benefit Adjustment Factors* and the Full Cost Adjustment Factors are contained in 18 tables. The first nine tables present the *Inflated Lifecycle Benefit Adjustment Factors* that can be used by all the PAs. The tables are based primarily on data contained in the California 2009 DEER Database. For each qualified equipment type, the median ratio of incremental savings to the full savings was calculated. Recall that *incremental savings* is defined as the annual energy use of the currently-on-the-market standard, minimally-compliant equipment minus the annual energy use of the high efficiency equipment subsidized by the program. *Full savings* is defined as the annual energy use of the old equipment in place minus the annual energy use of the high efficiency equipment subsidized by the program. These ratios along with the RULs, ranging from 1 year to the EUL minus 1 year, are shown in the look-up tables and are used to derive the factors needed to adjust the inflated lifecycle benefits.

The remaining nine tables present the *Full Cost Adjustment Factors* for the same equipment addressed in first nine tables for the same RUL ranges. For each qualified equipment type, the median ratio of incremental costs to the full costs was calculated. Recall that *incremental cost* is defined as the full cost of new efficient equipment minus the cost of the currently-on-the-market standard, minimally-compliant equipment, plus the time value penalty. *Full cost* is simply the cost (including installation) of the new efficient equipment.

To use these tables of typical ratios, a PA must have gathered the following four pieces of information:

1) the EUL of the new efficient equipment,
2) the RUL of the old equipment in place,
3) the full savings of the equipment (annual energy use of the old equipment in place minus the annual energy of the high efficiency equipment supported by the program), and
4) the full costs (including installation)

The EUL for a given measure is obtained from Table 1 below, which is a compilation of the EULs for all the relevant measures in the consolidated Technical Manual (effective January 1, 2011) that could qualify for early replacement[5]. The RUL[6], the full savings, and the full costs

[3] Full costs include the capital cost of the new efficient equipment plus installation cost.

[4] If a PA can calculate its own ratios of incremental savings to full savings and incremental cost to full cost, a second set of tables is available that contain inflated lifecycle savings adjustment factors and full cost adjustment factors. The focus of this paper is on the DEER-based ratios.

[5] Early replacement is inappropriate for such equipment as wall insulation, right sizing, setback thermostats, and submetering, since nothing is being replaced. Lighting equipment has also been excluded, since it is expected to be treated as pre-qualified.

[6] Upon request, Staff will provide a suggested questionnaire to assist in the determination of the RUL.

are provided by the program implementer. Table 1 also presents the normal replacement baseline equipment against which each of the 29 measures covered in this table is compared. The lookup tables apply only to the 23 measures without an ***a*** or ***b*** superscript in Table 1.

**Table 1. Early Replacement Measures, EULs, and Normal Replacement Baselines**

| Measures | EUL | Normal Replacement Baseline |
|---|---|---|
| Heat Pump Water Heater: Residential | 10 | Code Electric Storage Water Heater |
| Room Air Conditioner: Residential | 10 | EPACT[c] Room Air Conditioner |
| Clothes Washer: Single Family: Residential | 11 | EPACT Clothes Washer |
| ENERGY STAR Dishwashers: Residential | 11 | EPACT Dishwasher |
| Water Heater: Gas: Residential | 11 | Code Gas Storage Water Heater |
| Energy Star Dehumidifier: Residential[a] | 12 | Standard Efficiency Dehumidifier |
| Refrigerators: Nonresidential | 12 | EPACT Refrigerator |
| Indirect Water Heaters: Residential | 13 | Code Gas Storage Water Heater |
| Water Heater: Electric: Residential | 13 | Code Electric Storage Water Heater |
| Clothes Washer: Multi-Family Residential | 14 | EPACT Clothes Washer |
| Air Compressor Upgrade: Nonresidential | 15 | Standard Efficiency Rotary Screw Compressor |
| Central Air Conditioning: Residential | 15 | Code Central AC with gas heat |
| Central Air Source Heat Pumps: Residential | 15 | Code Central Air Source Heat Pump |
| Cool Roof: Nonresidential[a] | 15 | Standard Roof |
| Cooling Tower: Nonresidential[a] | 15 | Standard Efficiency Cooling Tower |
| Efficient Air-Cooled Refrigeration Condenser: Nonresidential[a] | 15 | Standard Efficiency Refrigeration Condenser |
| Indirect Water Heaters: Nonresidential | 15 | Code Gas Storage Water Heater |
| Motors: Nonresidential[b] | 15 | EISA[d] Minimum Efficiency Motor |
| Packaged Air Conditioners (Central AC): Nonresidential | 15 | Code Packaged Air Conditioner |
| Packaged Air Source Heat Pumps (CAC Cooling Only): Nonresidenti | 15 | Code Packaged Air Source Heat Pump |
| Water Heaters: Nonresidential (Gas & Electric) | 15 | Code Storage Water Heater |
| Refrigerators: Residential | 17 | EPACT Refrigerator |
| Chillers: Nonresidential | 20 | Code Chiller |
| Gas Furnaces and Boilers: Nonresidential | 20 | Code Furnace and Boiler |
| High Efficiency Gas Furnaces: Residential | 20 | Code Furnace |
| High Performance Glazing: Nonresidential[b] | 20 | Code Glazing |
| High Performance Windows (Gas Heating Only): Residential | 20 | Code Window |
| Instantaneous Water Heater: Residential | 20 | Code Storage Water Heater |
| Gas Boilers: Residential | 25 | Code Boiler |

[c] Efficiency standards promulgated by the Energy Policy and Conservation Act of 2005
[d] Efficiency standards promulgated by the Energy Independence and Security Act of 2007

For those measures assigned an ***a***, the efficiency of the old in-place unit is still the common practice or no new standards have been adopted, i.e., the baseline for the full savings and the incremental savings are the same. As a result, the ratio of incremental to full savings is near 1.0, meaning that a PA can claim the full savings for the entire EUL of the new equipment (areas **X** and **Y** in Figure 3). Therefore, the lookup tables do not apply.

For those measures assigned a ***b***, the high efficiency equipment subsidized by the program is consistent with current code or standards. For these measures, the incremental savings are zero and thus the ratio of incremental to full savings is 0.0.This means that a PA can claim full savings for only the RUL (area X in Figure 4), after which the high-efficiency replacement would have occurred anyway. Therefore, the lookup tables do not apply.

**Figure 3**. Efficiency of the Old In Place Unit Is Still the Common Practice Or No New Standards

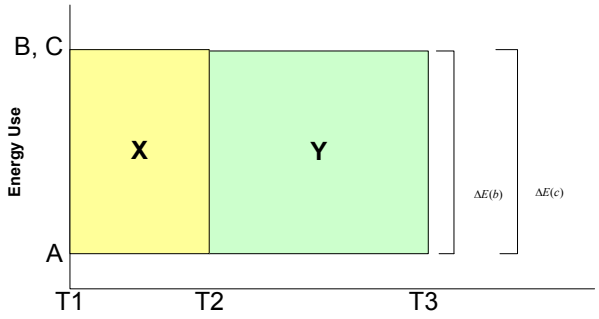
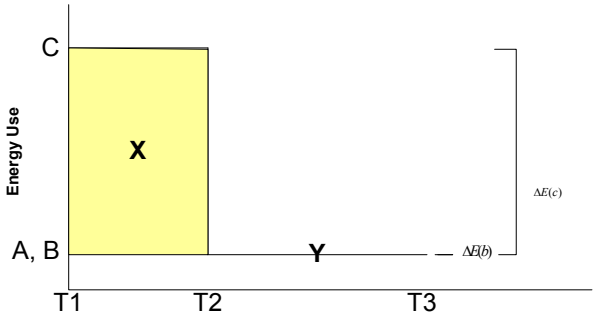



**Figure 4**. High Efficiency Equipment Subsidized by the Program Is Consistent with Current Code Or Standards

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T2 – T1 = Expected remaining useful life (RUL) of the existing equipment
T3 – T2 = Expected remaining EUL of the new efficient equipment

After obtaining the four pieces of information listed above, the program implementer can determine the appropriate *Inflated Lifecycle Benefits Adjustment Factor* by which to multiply the inflated lifecycle benefits and the full cost adjustment factor by which to multiply the full costs. These adjusted inflated lifecycle benefits and adjusted full costs are to be used in the TRC ratio in the screening of measures in specific projects.

A third variable must also be calculated, the *Adjusted EUL*. The *Adjusted EUL* is defined as that period of years over which the full savings would be claimed such that it matches the present value dollar benefits of the underlying dual baseline. That is, the EUL of the new equipment in Figure 5 below, represented by **Tx – T1**, is adjusted so that the present value of lifecycle benefits represented by area **X** in Figure 5 is equivalent to the present value of the lifecycle benefits represented by the sum of areas **X** and **Y** in Figure 1.

The longer the RUL, the larger the adjusted EUL is. This follows the same logic as the case of the *Inflated Lifecycle Benefit Adjustment Factors* except that the result is an *Adjusted EUL* (that portion of the EUL for which the PV of using the full savings would equal the PV of the dual baseline savings).

**Figure 1. Lifecycle Savings: Dual Baseline**

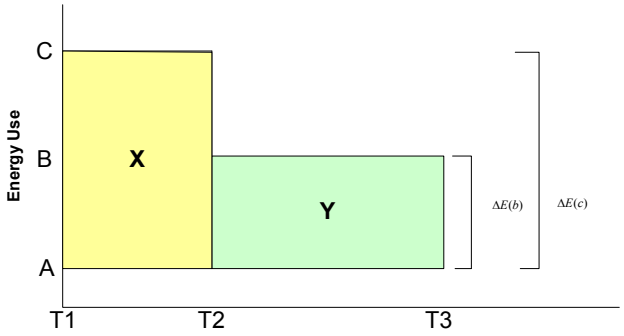


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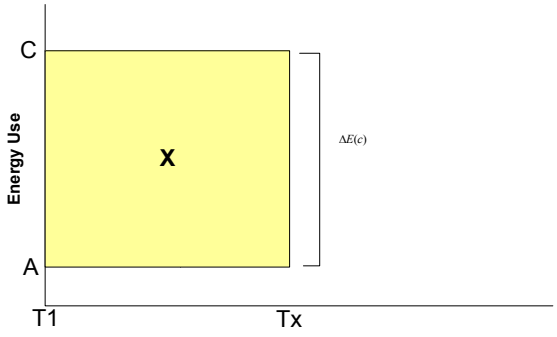
**Figure 5: Lifecycle Savings: Approximation to Dual Baseline**




## Table Organization

The DEER-based tables are divided into three groups of nine tables each:

- Inflated Lifecycle Benefit Adjustment Factors
- Adjusted EULs
- Full-Cost Adjustment Factors

Each set of tables addresses the same 23 measures or varieties of measures with each set of measures grouped by the EUL. Tables 2, 3, and 4 present the *Inflated Lifecycle Benefit Adjustment Factors*, the *Adjusted EULs* and the *Full Cost Adjustment Factors* for a group of measures with an EUL of 15 years.

**Table 2.** Inflated Lifecycle Benefit Adjustment Factors: Central Air Conditioners, Air Source Heat Pumps, Non-Res Water Heaters, Indirect Water Heaters, and Air Compressor Upgrades

| | Central Air conditioner (SEER 14) | Central Air conditioner (SEER 15) | Central Air conditioner (SEER 16) | Central Air conditioner (SEER 17) | Central Air conditioner (SEER 18) | DHW-E | DHW-G | Indirect Water Heater-G | Air Compressor Upgrade-E |
|---|---|---|---|---|---|---|---|---|---|
| | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Non-Res | Non-Res | Non-Res | Non-Res |
| | Median Ratio of Incremental Savings to Full Savings | | | | | | | | |
| | 0.19 | 0.31 | 0.38 | 0.44 | 0.48 | 0.60 | 0.21 | 0.34 | 0.48 |
| RUL | Artificial Lifecycle Benefit Adjustment Factors | | | | | | | | |
| 1 | 27% | 35% | 50% | 50% | 56% | 63% | 35% | 42% | 50% |
| 2 | 35% | 43% | 50% | 56% | 56% | 69% | 35% | 49% | 56% |
| 3 | 43% | 50% | 56% | 56% | 63% | 69% | 42% | 49% | 63% |
| 4 | 50% | 56% | 56% | 63% | 69% | 75% | 49% | 56% | 69% |
| 5 | 56% | 63% | 63% | 69% | 69% | 75% | 56% | 63% | 69% |
| 6 | 56% | 63% | 69% | 69% | 75% | 80% | 63% | 69% | 75% |
| 7 | 63% | 69% | 75% | 75% | 75% | 80% | 63% | 69% | 75% |
| 8 | 69% | 75% | 75% | 80% | 80% | 86% | 69% | 75% | 80% |
| 9 | 75% | 80% | 80% | 80% | 86% | 86% | 75% | 80% | 86% |
| 10 | 80% | 80% | 86% | 86% | 86% | 91% | 80% | 86% | 86% |
| 11 | 86% | 86% | 86% | 91% | 91% | 91% | 86% | 86% | 91% |
| 12 | 91% | 91% | 91% | 91% | 91% | 95% | 91% | 91% | 91% |
| 13 | 91% | 95% | 95% | 95% | 95% | 95% | 91% | 96% | 95% |
| 14 | 95% | 95% | 95% | 95% | 95% | 100% | 96% | 96% | 95% |
| EUL = | 15 | | | | | | | | |

**Table 3**. Adjusted EULs: Central Air Conditioners, Air Source Heat Pumps, Non-Res Water Heaters, Indirect Water Heaters, and Air Compressor Upgrades

| | Central Air conditioner (SEER 14) | Central Air conditioner (SEER 15) | Central Air conditioner (SEER 16) | Central Air conditioner (SEER 17) | Central Air conditioner (SEER 18) | DHW-E | DHW-G | Indirect Water Heater-G | Air Compressor Upgrade-E |
|---|---|---|---|---|---|---|---|---|---|
| | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Non-Res | Non-Res | Non-Res | Non-Res |
| | Median Ratio of Incremental Savings to Full Savings | | | | | | | | |
| | 0.19 | 0.31 | 0.38 | 0.44 | 0.48 | 0.60 | 0.21 | 0.34 | 0.48 |
| RUL | Adjusted EULs | | | | | | | | |
| 1 | 3 | 4 | 6 | 6 | 7 | 8 | 4 | 5 | 6 |
| 2 | 4 | 5 | 6 | 7 | 7 | 9 | 4 | 6 | 7 |
| 3 | 5 | 6 | 7 | 7 | 8 | 9 | 5 | 6 | 8 |
| 4 | 6 | 7 | 7 | 8 | 9 | 10 | 6 | 7 | 9 |
| 5 | 7 | 8 | 8 | 9 | 9 | 10 | 7 | 8 | 9 |
| 6 | 7 | 8 | 9 | 9 | 10 | 11 | 8 | 9 | 10 |
| 7 | 8 | 9 | 10 | 10 | 10 | 11 | 8 | 9 | 10 |
| 8 | 9 | 10 | 10 | 11 | 11 | 12 | 9 | 10 | 11 |
| 9 | 10 | 11 | 11 | 11 | 12 | 12 | 10 | 11 | 12 |
| 10 | 11 | 11 | 12 | 12 | 12 | 13 | 11 | 12 | 12 |
| 11 | 12 | 12 | 12 | 13 | 13 | 13 | 12 | 12 | 13 |
| 12 | 13 | 13 | 13 | 13 | 13 | 14 | 13 | 13 | 13 |
| 13 | 13 | 14 | 14 | 14 | 14 | 14 | 13 | 14 | 14 |
| 14 | 14 | 14 | 14 | 14 | 14 | 15 | 14 | 14 | 14 |
| EUL = | 15 | | | | | | | | |

**Table 4**. Full Cost Adjustment Factors: Central Air Conditioners, Air Source Heat Pumps, Non-Res Water Heaters, Indirect Water Heaters, and Air Compressor Upgrades

| | SEER 14 | SEER 15 | SEER 16 | SEER 17 | SEER 18 | DHW-E | DHW-G | Indirect Water Heater | Air Compressor Upgrade |
|---|---|---|---|---|---|---|---|---|---|
| | 0.10 | 0.20 | 0.26 | 0.31 | 0.37 | 0.25 | 0.22 | 0.93 | 0.46 |
| RUL | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Res/Non-Res | Non-Res | Non-Res | Non-Res | Non-Res |
| 1 | 15% | 24% | 30% | 35% | 40% | 29% | 26% | 93% | 49% |
| 2 | 19% | 28% | 34% | 38% | 43% | 33% | 30% | 94% | 51% |
| 3 | 23% | 32% | 37% | 41% | 46% | 36% | 34% | 94% | 54% |
| 4 | 27% | 35% | 40% | 44% | 49% | 39% | 37% | 94% | 56% |
| 5 | 31% | 39% | 43% | 47% | 52% | 43% | 40% | 95% | 59% |
| 6 | 35% | 42% | 46% | 50% | 54% | 46% | 43% | 95% | 61% |
| 7 | 38% | 45% | 49% | 53% | 57% | 48% | 46% | 95% | 63% |
| 8 | 41% | 48% | 52% | 55% | 59% | 51% | 49% | 95% | 65% |
| 9 | 44% | 51% | 54% | 57% | 61% | 54% | 52% | 96% | 67% |
| 10 | 47% | 53% | 57% | 60% | 63% | 56% | 54% | 96% | 68% |
| 11 | 50% | 56% | 59% | 62% | 65% | 58% | 57% | 96% | 70% |
| 12 | 53% | 58% | 61% | 64% | 67% | 61% | 59% | 96% | 72% |
| 13 | 55% | 60% | 63% | 66% | 69% | 63% | 61% | 97% | 73% |
| 14 | 57% | 62% | 65% | 67% | 70% | 65% | 63% | 97% | 74% |
| EUL = | 15 | | | | | | | | |

In each table, the left *column* contains the RULs from 1 year through the EUL minus 1 year. Table 2 presents Inflated Lifecycle Benefit Adjustment Factors for measures with an EUL of 15 years. So, Table 2 contains RULs from 1 through 14. The *first row* of each table contains the names of each measure addressed in the table. The *second row* of each table indicates whether the measure is residential, non-residential or both. The *third row* of each table lists the median ratio associated with each measure. For Tables 2 and 3, the ratio is the ratio of the incremental savings to the full savings for each measure. For Tables 4, the ratio is the ratio of the incremental costs to the full costs for each measure. The remaining *cells* in the matrix contain:

- For Table 1, the cells contain the *Inflated Lifecycle Benefit Adjustment Factors*
- For Table 2, the cells contain the *Adjusted EULs*
- For Table 3, the cells contain the *Full-Cost Adjustment Factors*

## Notes on Interpretation of Lookup Tables

Here are a few notes on interpreting the information in each set of tables:

- *Table 2*: The longer the RUL, the larger the share of the inflated lifecycle benefits that a PA can claim. Also, the greater the ratio of incremental savings to full savings is, the larger the share of the inflated lifecycle benefits that a PA can claim. Consider the following example of equipment with an EUL of 10 years and annual kWh use of 2,000 kWh that is removed in its $6^{th}$ year (RUL = 4 years) and replaced with an energy-efficient version of the equipment with an annual kWh use of 1,400 kWh. The full savings are 600 kWh (2,000 - 1,400). It is assumed that in four years the customer would have installed equipment that, at a minimum, met the current efficiency code of annual energy use. The ratio will change depending on the efficiency of the code/standard equipment:

  - If the kWh use associated with code/ standard is 1600 kWh, then the incremental savings = 200 (1600 – 1400), and the ratio of incremental savings to full savings = 0.33 (200/600).

  - If the kWh use associated with code/standard is 1800 kWh, then the incremental savings = 400 (1800 – 1400), and the ratio incremental savings to full savings = .67 (400/600).

  A less strict code (one that allows higher consumption) allows a PA to claim a larger share of the inflated lifecycle benefits. In other words, the higher the kWh use associated with the code/standard equipment, the more the program is accomplishing in avoiding standard equipment.

- *Table 3*: The Adjusted EUL is defined as that period of years over which the full savings would be claimed such that it matches the present value dollar benefits of the true underlying dual baseline. PAs can obtain the adjusted EULs from the DEER-based tables based on typical ratios of incremental savings to full savings or from the PA-based tables if a PA can calculate its own savings ratios. The adjusted EUL is not used for TRC screening, but for the program's tracking data base. The tables are organized in the same way as the earlier tables. The only difference is that the cells in the matrix contain adjusted EULs.

- *Table 4*: The longer the RUL, the larger the share of the total costs for a PA to include (larger time value penalty). Also, the greater the ratio of incremental costs to full costs is, the larger the share of the total costs for a PA to include. Continuing with the above example, assume that the full cost of the energy efficient equipment is $2,000. It is

assumed that in four years the customer would have installed code/standard equipment The ratio will change depending on the cost of the code/standard equipment:

- If the full cost of the code/standard equipment is $1,400, then the incremental cost = $600, and the ratio = ratio 0.30 ($600/$2,000).

- If the full cost of the code/standard equipment is $1,800, then the incremental cost = $200 and the ratio = ratio 0.10 ($200/$2,000).

The higher cost of the standard/code equipment, which lowers the incremental cost, allows a PA to take into account a smaller portion of the full cost of the efficient measure when calculating a TRC. In other words, the higher the cost of the code/standard equipment which would have been spent without the program, the lower the cost of the program.

If a PA is able to calculate the ratio of the incremental savings to full savings and/or the ratio of incremental costs to full cost, then they may choose to use the second set of tables covering the same groups of measures to identify the correct *Inflated Lifecycle Benefits Adjustment Factor* or the *Adjusted EUL* and the *Full Cost Adjustment Factor*.

**Example**

Consider the following example for the group of five measures addressed in Tables 2 through 4, each with an EUL of 15 years. Table 2 presents the *Inflated Lifecycle Benefits Adjustment Factors* for these five measures. For central air conditioners, the program implementer must determine the SEER of the new efficient unit and estimate the RUL for the old unit in place and select the appropriate lifecycle benefits adjustment factor. For example, if the SEER of the new efficient unit is 17 and the estimated RUL is 4 years, then the *Inflated Lifecycle Benefits Adjustment Factor* of 0.63 can be identified in Table 1. That is, the inflated lifecycle benefits should be multiplied by 0.63. The *Adjusted EUL* of 8 years can be obtained from Table 3. The *Full-Cost Adjustment Factor* can be identified in Table 4 for a central air conditioner with a SEER of 17 and an estimated RUL of 4 years. The full cost of the new efficient central air conditioner should be multiplied by the full-cost adjustment factor of 0.44.

**Program-Tracking Database Requirements**

In cases of early replacement, the following six additional variables must be added to the program tracking database.[7]

1. An *Early Replacement Flag* indicating that the record is a case of early replacement,
2. The *Full Savings*,
3. The *Adjusted Full Cost* (full cost multiplied by the full-cost adjustment factor),
4. The *Ratio of Incremental Savings to Full Savings*,
5. The *Ratio of Incremental Costs to Full Costs*, and

[7] Further procedural steps may be required to promulgate these additions to the database. If PAs accordingly choose to postpone adding these fields, convenient data retention would be prudent.

6. The *Adjusted EUL*.

## Discussion

This is admittedly a rather simple solution to a very complicated and vexing problem for the DPS and the PAs. By using ratios from the DEER Database, it avoids having to obtain measure-specific incremental savings and cost data for each case of early replacement. It also facilitates the calculation of TRCs in standard benefit cost software. However, this approach is not without its problems. First, it shortens the stream of savings over time, leaving the New York Independent System Operator with a somewhat distorted view of available resources. In addition, by shortening the stream of savings, the benefits are somewhat distorted since avoided costs are increasing over time and the time over which the present value is calculated is shortened[8]. However, all of these effects are relatively small. For example, the compound annual growth rate of avoided costs over the next 20 years is only 0.8%. DPS considers all of these effects acceptable compared with the effects of other solutions such as claiming the full savings for the entire EUL.

## References

Jacobs, Pete, Brian Evans, Nick Hall, Paul Horowitz, Rick Ridge, Gil Peach, and Ralph Prahl. 2010. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Residential, Multi-Family, and Commercial/Industrial Measures. Prepared for the New York Department of Public Service.

[8] Of course, PAs can use the DEER-based savings and cost ratios to directly estimate the incremental savings and costs for the remaining EUL for each measure and calculate measure-level and program-level TRCs assuming available software can be modified.